

Search for Higgs in Leptogenic Susy models

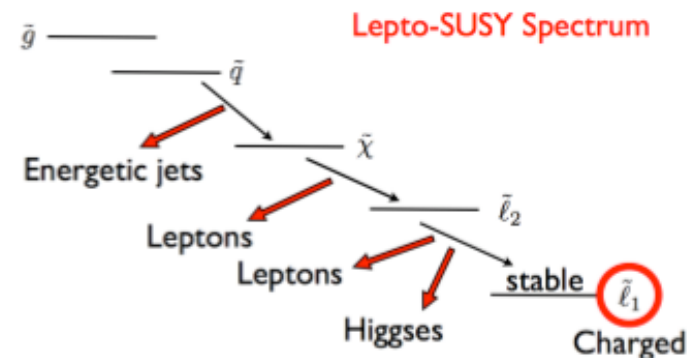
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The model

- Leptogenic Supersymmetry
 - ♦ SUSY scenario characterized by cascade decays with copious lepton production;
 - ♦ Striking signatures that can be probed with just 200 pb^{-1} at LHC 10TeV
 - Long-lived sleptons
 - Several Isolated leptons
 - Energetic jets
 - No MET
 - Copious Higgs production...



V.Sanz et al. Phys.Rev.D80:035010,2009.

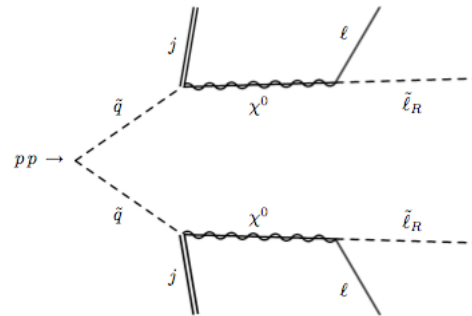
Final State topologies with no Higgs



Main Production mechanism: pair production of squarks $pp \rightarrow \tilde{q} \tilde{q}^*, \tilde{q} \tilde{q}$

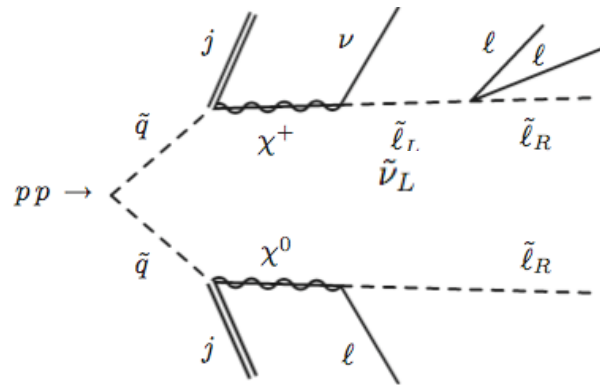
Four-Lepton Channels

Both gauginos decay to stable sleptons and leptons



Five-Lepton Channels

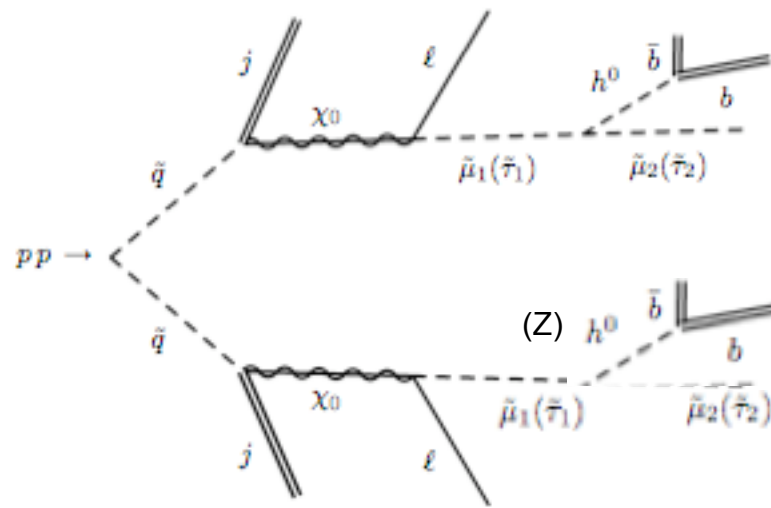
Long decay chain for charginos decaying to stable sleptons and leptons



Six-Leptons when combining the two above

Higgs production and decay

- The SM-Higgs boson in this scenario is light enough to not decay into WW ;
- It decays predominantly into $b\bar{b}$ ($\text{Br} = 80\%$)
- Higgs is produced in cascade decays and it's free of most of the SM background
 - ♦ Clean $b\bar{b}$ invariant mass distribution study





Status and Plans

- Using a special input file (Madgraph) , we generated events in the Athena environment and studied them at generator level and at jet level using the JetTruthCollection (Summer 2009)
- These studies were considered necessary before submitting a request for the generation of a large sample through the central production service (September 14, Higgs in complex states ATLAS meeting)
- We analyzed two samples:
 - ♦ One with only Higgs production (signal);
 - ♦ One with all processes (which represents the background)



Status and Plans (cont'd)

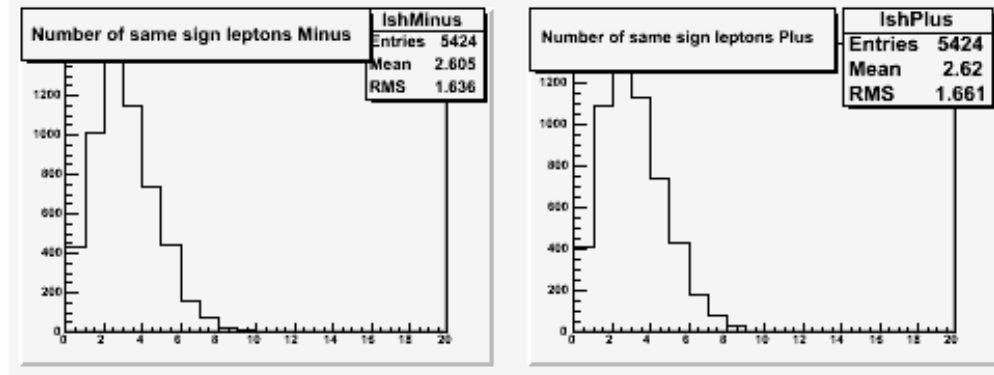
- We will generate completed simulated events in the next few weeks and proceed with a full simulated analysis by the end of the year
 - ♦ This will be used as the template for a real data analysis;
 - ♦ This will be used as a testbed for fatras simulation comparison with fullSim.
- We will also design a simple analysis module to run on data and select events with leptogenic signatures (signature based analysis)
 - ♦ The signature is striking per se!

Studies

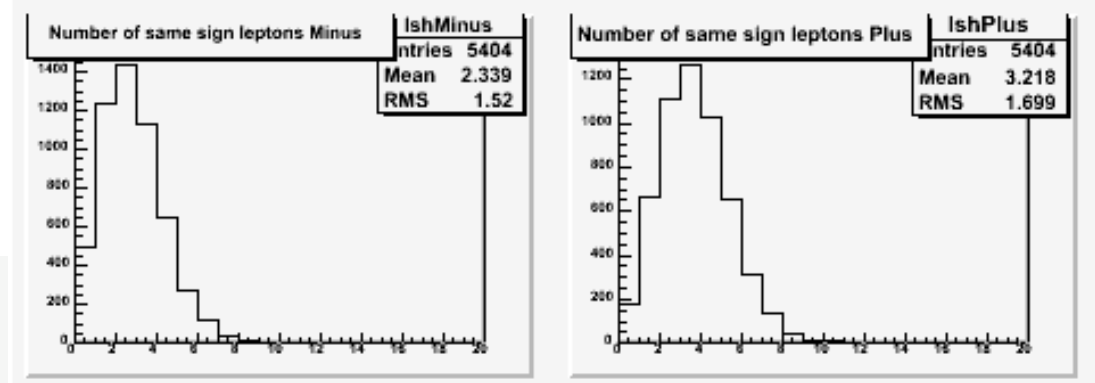


- Check leptons and sleptons multiplicity
 - ♦ Co-sleptons scenario - our final sample will only include staus in the final state
- Check the Higgs mass reconstructed from the b-partons
 - ♦ Select b's and check for their mother
 - ♦ Select Higgs and check for its children
 - Same result in both procedures
- Reconstructed mass of third and fourth jet (as from the theory paper)
 - ♦ Initially the mass spectra were way higher
 - ♦ High jet multiplicity (too high)
 - ♦ Select jets matched to b's in DeltaR and plots their reco mass
 - Mass structure observed.
 - ♦ TruthJet multiplicity and removing the “slepton-jets”

Sleptons and Leptons

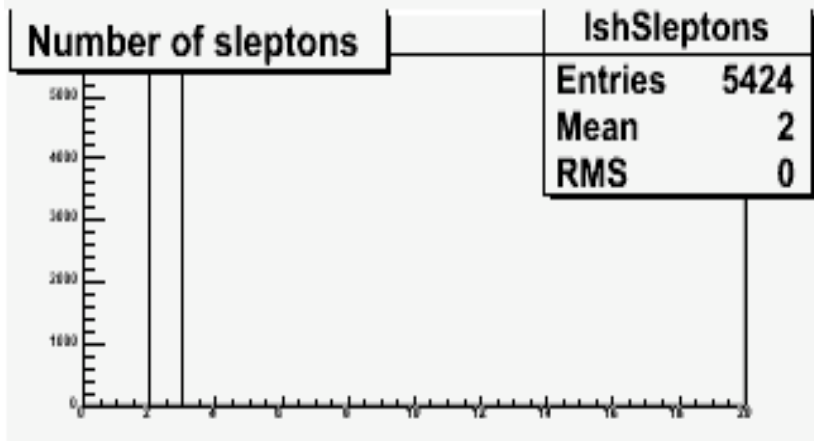


Higgs Only

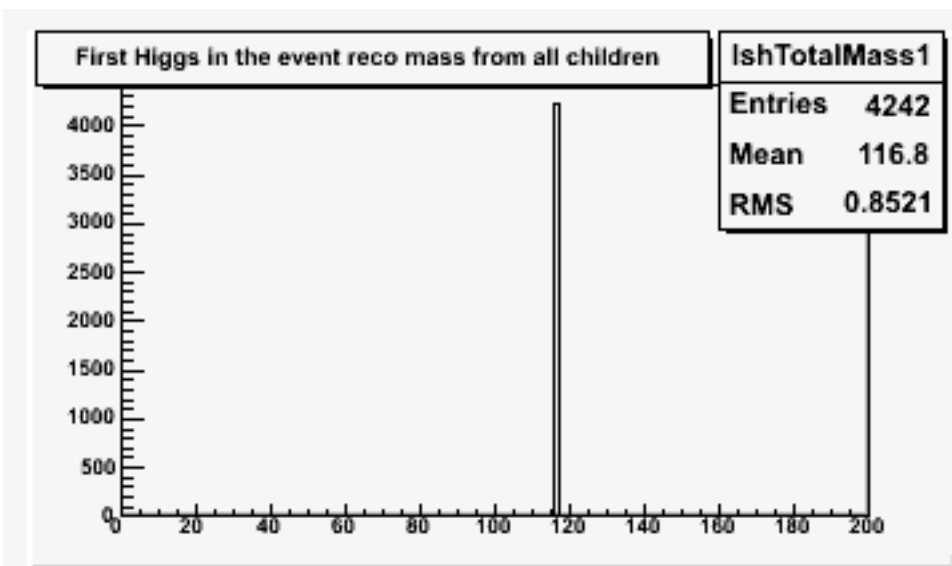


All-Processes

The asymmetry is expected
(three-body decay of
sleptons)



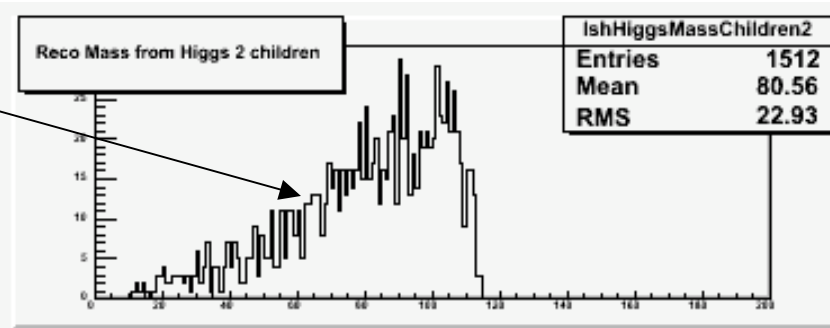
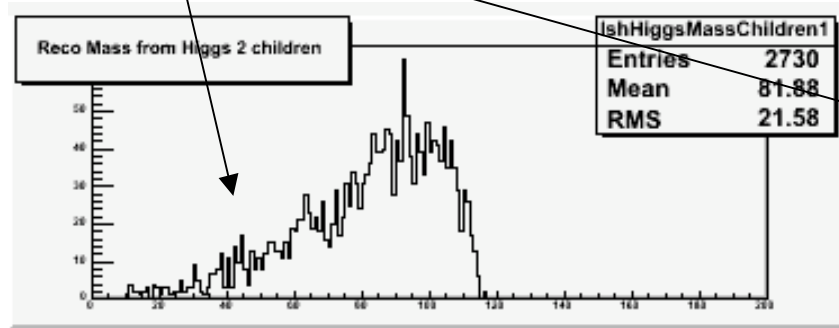
Bbar Mass from ALL children



Select a Higgs and check for its children to select a bbar pair:

- ===Event number 5424 Higgs has 13 children with ID and status of the children
- ID = 5 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = -2 status = 2
- ID = 2 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = -5 status = 2

Low tail due to radiation



Jets

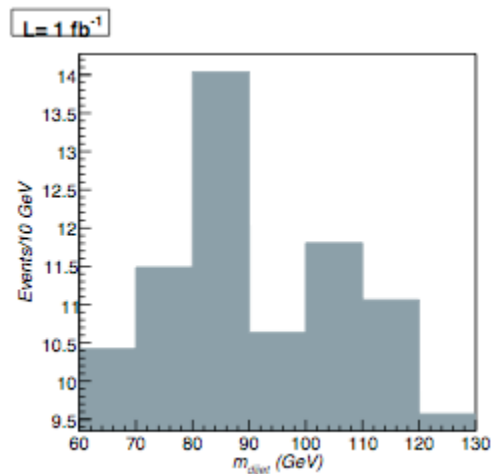


- At generator level we cannot select light jets, there are too many light quarks and gluons coming from the PS.
- We added a TruthJetCollection for jets of cone 0.4 and 0.7
- TruthJets are formed with a JetClu algorithm that uses the list of final state particle in the MC (no calo energies!)
- Interested in the reconstructed Higgs Mass

Mass Combination jet 3-4

In the theory paper, the authors select events with 1 or 2 sleptons and reconstruct the mass of the 3rd and 4th jet, with $PT > 25$

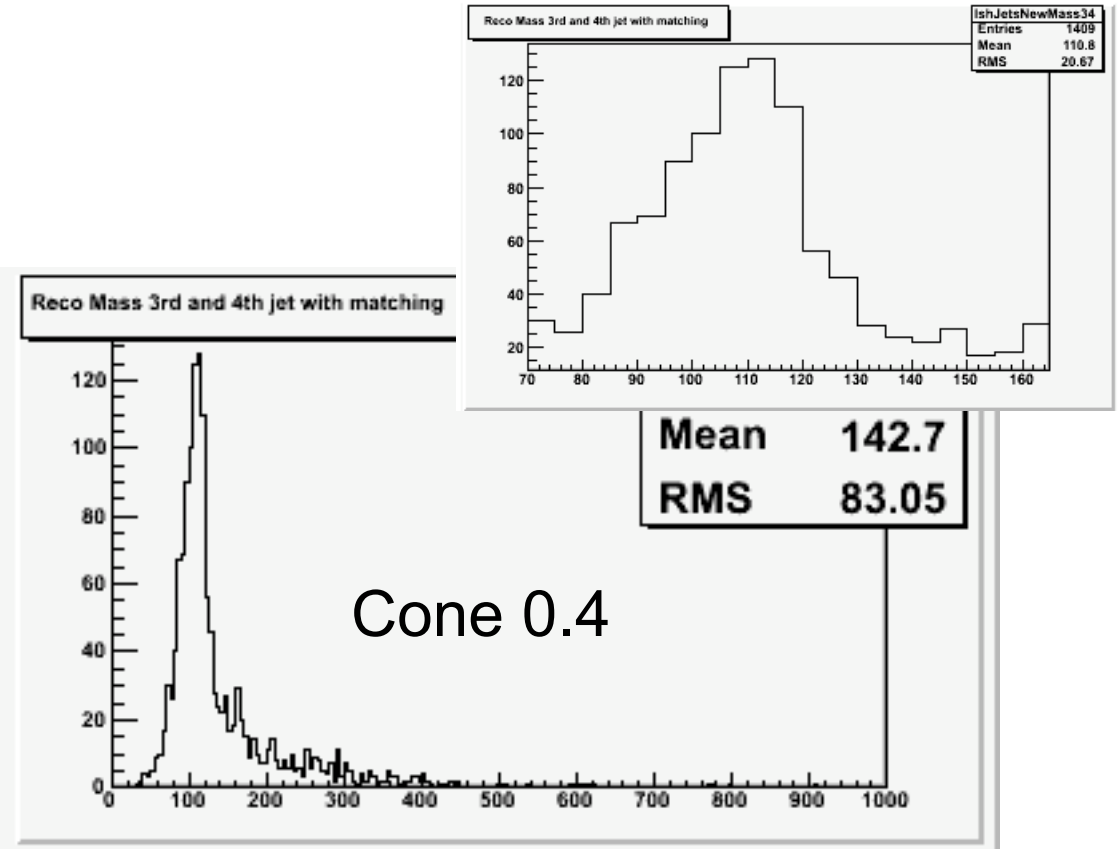
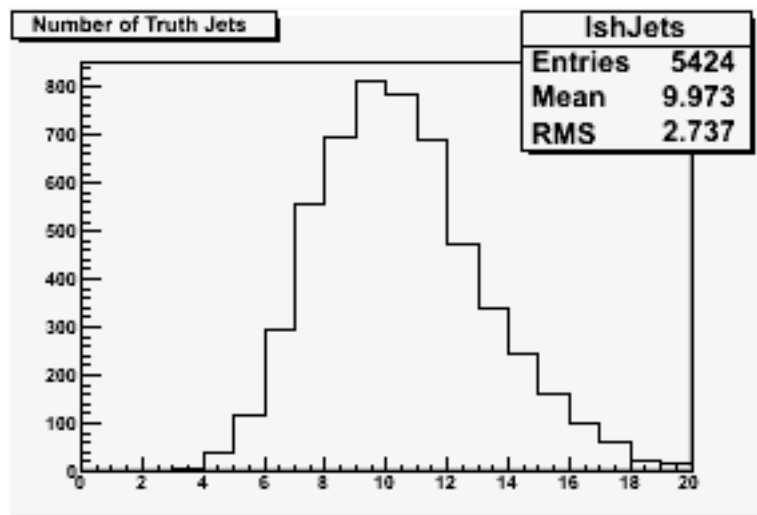
Clear Z and Higgs peaks are observed



We reproduced the result but we added a DeltaR constraint between the reco jet and the b-parton (b-tagging will be eventually used in the real analysis)

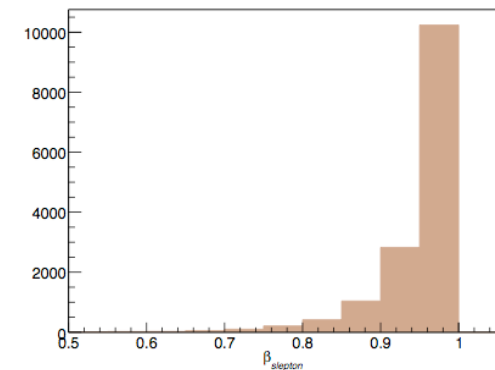
Reconstructed Higgs Mass

- We also had to modify the stable truth collection before running JetTruthAlgorithm to remove the sleptons from the list of final state particles to be used for jet reco (extra energetic jets!)



Other Issues

- In the leptogenic scenario the sleptons will behave like CHAMPs, ie slow moving particle crossing the detector with MIP-like signature.
- A challenge in this case will be the correct assignment of bunch crossing;
- Efficiencies to correctly assign the slow-moving particle to BC decreases with β : for $0.8 < \beta < 1.0$ the efficiency is $\sim 80\text{-}100\%$ *
 - ♦ Most of our sleptons will have $\beta > 0.8$
- We are working on correctly setup the simulation and reconstruction flags for this process.



* arXiv:0901.0512

Conclusions



- We tested the sample generation of events with Higgs produced in association with leptons and jet in the framework of leptogenic SUSY;
- We are submitting a formal request for sample generation through the ATLAS central production facility.
- The sample will serve as a template for a cut-based analysis
- We will also monitor the data for this very striking signature (4 leptons + 4 jets) in a signature-based fashion

Backup Slides



The model (cont'd)



Input	m_3	2000 GeV		
	n_1	4.8		
	n_2	3.9		
	n_3	2.2		
	n_4	6.7		
	$\tan \beta$	10		
	$\text{sgn} \mu$	+		
Output (GeV)	$m_{\tilde{g}}$	1938	$m_{\tilde{u}_L}$	949
	$m_{\tilde{\chi}_1^\pm}$	291	$m_{\tilde{u}_R}$	920
	$m_{\tilde{\chi}_2^\pm}$	676	$m_{\tilde{d}_L}$	952
	$m_{\tilde{\chi}_4^0}$	676	$m_{\tilde{d}_R}$	919
	$m_{\tilde{\chi}_3^0}$	353	$m_{\tilde{t}_1}$	920
	$m_{\tilde{\chi}_2^0}$	302	$m_{\tilde{t}_2}$	962
	$m_{\tilde{\chi}_1^0}$	271	$m_{\tilde{\ell}_L}$	248
	m_h	115	$m_{\tilde{\ell}_R}$	108
	m_{H^\pm}	387	$m_{\tilde{\nu}}$	236
	m_A	379	$m_{\tilde{\tau}_1}$	106
	m_{H_0}	379	$m_{\tilde{\tau}_2}$	249

Table 1: A sample spectrum calculated with SUSY-HIT.